# Concurrent Topological Design of Material and Structure Using BESO Method

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A topological optimization algorithm is developed based on the bi-directional evolutionary structural optimization (BESO) method for the concurrent optimal design of macrostructure and material microstructure. Effective material properties are obtained by applying the homogenization theory to the periodic microstructure. By coupling the sensitivity analyses at both macrostructural and microstructural levels, the proposed BESO approach integrates the optimizations of the macrostructure and the periodic material microstructure into one system and conducts the topological design on two different scales simultaneously. Several 2D and 3D numerical examples are presented to demonstrate the effectiveness of the proposed optimization algorithm. A variety of optimal macrostructures and optimum material microstructures have been obtained concurrently.

**Keywords:** Topological optimization, BESO, Concurrent design, Multi-scale